EPA United States Environmental Protection Agency

Office of Emergency and Remedial Response (5204G)

EPA 540-F-00-007
OSWER 9285.7-33
Guidance Document
December 1999

IEUBK Model Soil/Dust Ingestion Rates

Purpose and Summary

This short sheet provides recommendations on substitution of default soil/dust ingestion rates in the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK model). *In addition to reviewing basic information pertaining to this* parameter, the short sheet addresses questions on the adjustment of default soil/dust ingestion values.

This short sheet reaffirms the provisions of the *Administrative Reform for Lead Risk Assessment* that requires a review of new data on soil ingestion before use in the IEUBK model by the EPA's Office of Emergency and Remedial Response (OERR). This review not only promotes better science but also promotes sharing of information so that all EPA Regions can benefit from improvements in soil/dust ingestion data.

Soil/Dust Ingestion Rates

One of the parameters that the IEUBK model uses to estimate child blood lead concentrations is the ingestion of the mass of soil and household dust. Young children are primarily exposed to lead through fine particles of surface soil and household dust that adhere to their fingers and are incidentally ingested during normal hand-to-mouth activity. The rate at which soil/dust is ingested depends on a number of factors including a child's age, activity patterns, and total dust and soil accessible in the environment. Soil and dust ingestion rates discussed in this paper include both indoor and outdoor ingestion. The contribution of outdoor soil to interior dust is discussed in the MSD[1] short sheet that was issued in 1998.

Age Dependent Default Soil/Dust Ingestion Rates Used in the IEUBK Model

The age-specific default soil/dust ingestion rates recommended for use in the IEUBK model range from 0.085 to 0.135 g/day and are illustrated in Table 1. These values are representative of average daily intake rates; they do not incorporate variability in consumption patterns, nor do they reflect pica behavior. Clearly, there are children who will have soil and dust ingestion rates higher than the values reported in Table 1.

While there is uncertainty associated with the soil/dust ingestion rate values, a review conducted by the Technical Review Workgroup (TRW) determined that these values are appropriate and representative estimates of soil ingestion for U.S. children. This is especially true for application in the IEUBK model because the model has been calibrated and validated using these default values.

TABLE 1– IEUBK Soil/Dust Ingestion Defaults by Age

Age Group (years)	IEUBK Model Defaults (g/day)
0–1	0.085
1–2	0.135
2–3	0.135
3–4	0.135
4–5	0.100
5–6	0.090
6–7	0.085

Source: U.S. EPA, 1994

Basis for Default Values

As indicated in the *Guidance Manual for the IEUBK Model*, the development of default values for the rate of soil/dust ingestion involved a literature review and relied upon an analysis performed during a review of the National Ambient Air Quality Standards (NAAQS) for lead. The calibration of the IEUBK model employed these default values, and validation study results performed to date show good agreement between model estimates using these intake values and empirical blood lead measurements. For the purposes of the IEUBK model it is recommended that the soil and dust ingestion rates be defined on an age-specific basis as shown in Table 1. By contrast, the *Exposure Factors Handbook* (U.S. EPA, 1997; U.S. EPA, 1999) recommends the use of a mean of 0.10 g/day for soil ingestion and reports a value of 0.20 g/day as a conservative estimate of the mean for soil ingestion. Given this information from the *Exposure Factors Handbook*, the values recommended for use in the IEUBK model represent central values within the range of values observed in the soil and dust ingestion studies. The default soil and dust ingestion values are based on several observatio nal studies of soil ingestion in children. These studies were conducted in the U.S. by Binder *et al.* (1986), Clausing *et al.* (1987), Calabrese *et al.* (1989, 1991), van Wijnen *et al.* (1990), and Davis *et al.* (1990), utilizing trace elements to quantify soil ingestion rates. In general, this methodology constitutes a reasonable basis for estimating the quantity of soil ingested.

[1] M_{SD} is a variable in the dust lead *Multiple Source Analysis* module of the IEUBK model which represents the mass fraction of house dust that is derived from outdoor soil.

It is necessary to make a distinction between the quantity of soil ingested and the quantity of soil plus dust ingested. Logically, the latter quantity will be larger, and data from the soil ingestion studies support this theory (Davis *et al.*, 1990).

The experimental studies reporting estimates of soil ingestion have generally relied upon mass balance studies employing trace metals to estimate ingestion. While these studies have been useful to derive estimates of soil ingestion, they are subject to considerable uncertainty, as reflected in the variation in estimates for soil ingestion for the different trace metals. Many factors that are believed to have influenced these uncertainties. These factors include: lack of alignment in the measurement of trace metals in food and waste; confounding influence of trace metals from unknown sources; and loss of trace metals in urine (few studies examined trace metal loss in urine). For these reasons and because the IEUBK model has been calibrated and validated with the ingestion rate values in Table 1, the TRW strongly recommends these default estimates to support lead risk assessment analyses performed with the IEUBK model.

Substitution of Default Values of Ingestion Rates: Technical Considerations

The IEUBK model default values for the rate of soil/dust ingestion do not reflect differences associated with variables that may affect ingestion rates at different sites. Examples of such variables include ground cover, climate, activity patterns, and behavior. While inclusion of such information in a risk assessment is desirable, often such data are not available to support quantitative adjustment of ingestion rates in the IEUBK model.

Recognizing the technical difficulties of interpreting soil and dust ingestion studies, the *Administrative Reform for Lead Risk Assessment* specified that adjustments to the IEUBK model default ingestion rates be performed only after OERR recommends such a change. The process for obtaining a recommendation is to submit all information pertaining to the ingestion study to OERR for review by the TRW. The results of the TRW review will be sent to the requestor, and, if any improvement in the soil and dust ingestion estimate is warranted, will be incorporated into guidance and shared among other EPA Regions. This process promotes the sharing of data and consistency in lead risk assessments.

References

Binder, S., Sokal, D., Maughan, D. 1986. Estimating soil ingestion: The use of tracer elements in estimating the amount of soil ingested by young children. *Arch. Environ. Health* 41:341–345.

Calabrese, E., Barnes, R., Stanek, E. J., Pastides, H., Gilbert, C., Veneman, P., Wang, X., Lasztity, A., Kostecki, P. 1989. How much soil do young children ingest: An epidemiological study. *Reg. Toxicol. Pharmacol*. 10(2):123–137.

Calabrese, E., Stanek, E.J., Gilbert, C.E. 1991. Evidence of soil-pica behavior and quantification of soil ingested. *Human Experi Toxicol* 10:245–249.

Clausing, P., Brunekreef, B., van Wijnen. J.H. 1987. A method for estimating soil ingestion by children. *Int. Arch. Occup. Environ. Health* 59:73–82.

Davis, S., Waller, P., Buschbom, R., Ballou, J., White, P. 1990. Quantitative estimates of soil ingestion in normal children between the ages of 2 and 7 years: population-based estimates using aluminum, silicon, and Titanium as Soil Tracer Elements . *Arch. Environ. Health* 45(2):112–122.

U.S. Environmental Protection Agency. 1994. *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*. Office of Emergency and Remedial Response. EPA/540/R-93/081.

U.S. Environmental Protection Agency. 1996. *Administrative Reforms for Lead Risk Assessment*. Memorandum to EPA Regional Division Directors. Office of Emergency and Remedial Response. Washington, DC 20460.

U.S. Environmental Protection Agency. 1997. *Exposure Factors Handbook*. Office of Research and Development, Volume I-General Factors, EPA/600/P-95/002Fa, Office of Research and Development, Washington, DC 20460.

U.S. Environmental Protection Agency. 1999. *Exposure Factors Handbook*. EPA/600/C-99/001 Office of Research and Development, Washington, DC 20460.

Van Wijnen, J. H., Clausing, P. Brunekreef, B. 1990. Estimated Soil Ingestion by Children. *Environ. Res.* 51:147-162.